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Boletus atlanticus sp. nov., a new species of section *Luridi* from coastal dunes of NW Spain

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Abstract—*Boletus atlanticus,* found in coastal sand dunes in Galicia (NW of Spain) under *Cistus salviifolius* and maritime pines (*Pinus pinaster*), is described as a new species from section *Luridi* based on morphology. Morphological description, drawings of microscopic characters, and color pictures of the basidiomata are presented. A discussion about other close taxa of section *Luridi* is also outlined.

Key words— *Basidiomycota, Boletales,* taxonomy, Iberian Peninsula, Europe

Introduction

Mycological studies carried out in recent decades in the dunes ecosystems of Galicia (NW of Spain, Iberian Peninsula) along the Atlantic coast in sand-dominated areas with natural coastal vegetation and forested mainly with maritime pine (*Pinus pinaster* Aiton) have revealed several new species to science, including *Gyroporus ammophilus* (Castro & Freire 1989, 1995), *Agaricus freirei* (Blanco-Dios 2001), and *Leucocoprinus castroi* (Blanco-Dios 2003). Recently, in tertiary or gray dunes with vegetation dominated by *Cistus salviifolius* L. (*Cistaceae*) and a few maritime pines, several specimens of a *Boletus* species were collected. We determined from a detailed morphological study that the specimens belong in sect. *Luridi* Fr. based on their orange pores and variable blueing of the exposed yellow flesh.

After extensively reviewing the European and extra-European species of section *Luridi*, we concluded that this taxon does not correspond to any previously described species and describe it as a new species: *Boletus atlanticus*.

Materials & methods

The specimens were collected, documented and preserved using standard methods. Morphological descriptions are based on fresh material and analysis of photographs of fresh specimens. Microscopic observations were recorded both from fresh material and dried specimens rehydrated in 3% KOH. We used a solution of 1% Congo Red in water to observe cystidia (pleuro-, cheilo-, and caulocystidia) and Melzer's reagent to examine basidiospores, pileipellis and stipitipellis. Spore size is presented as (Min)(mean – SD)–(mean + SD)(Max), where Min = the lowest value measured, Max = the highest value, followed by the mean spore lengths and widths (Xm); Q = spore length : width ratios; and the mean volume (Vm) was determined using the formula $Vm = 4\pi/3\ a^2b$, where **a** is the radius of the minor axis and **b** the radius of the major axis (Breitenbach & Kränzlin 1991).

The maximum and minimum values and the length/width ratio (Q) of the pileipellis terminal cells were determined by sampling between the centre and the margin (Ladurner & Simonini 2003) in the superior layer of young sporocarps, as recommended by Singer (1965) and Muñoz (2005). Microscopical structures were documented by color microphotographs and line drawings on a light microscope equipped with a digital camera and a drawing tube device. The collected material has been deposited in the mycological herbarium LOU-Fungi (Centro de Investigación Forestal de Lourizán, Pontevedra, Spain).

Taxonomy

Boletus atlanticus Blanco-Dios & G. Marques, **sp. nov.** Plate 1, Fig. 1

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Boletus luridus *similis sed differt pileo ab rosaceo ad aurantiaco vel flavo et margo cremeo, pori primum aurantiaco et ochraceo, denique aurantiaco-ferrugineo, stipes ut cuticula flava, nisi in inferiore tertio, purpureo-rubro, sporis leviter plus grandis, caulocystidiis multiformis.*

Type: Spain, A Coruña, Santa Uxía de Ribeira, Aguiño, near of Penisqueira beach, 29TMH9708, 10 m, in tertiary or gray dunes, under *Cistus salviifolius* and *Pinus pinaster*, 29.X.2005, leg. F. Romano, J. Sampedro, A. Sampedro & J.B. Blanco-Dios (**Holotype**, LOU-Fungi 19418).

Etymology: the species epithet refers to the Atlantic Ocean coast of NW Spain where the specimens were found.

Pileus 65–155 mm broad, hemispheric to convex in age, smooth, glabrous, slightly viscid in wet weather; more intensely coloured when young, ranging from pink to orange on the disc, fading with age, becoming light brown on the disc and with various shades of pink, orange and yellow toward the cream colored margin, margin undulate and slightly projecting. When bruised, pileus surface changes to deep blue, greyish blue or greenish and, finally, to black blue. Hymenophore tubulose, tubes 8–15 mm long, adnate, yellow, changing to blue slowly when bruised or exposed. Pores small, compressed, oval (more abundant, 0.4–0.7 mm per pore) or triangular (less numerous and larger,

Plate. 1. *Boletus atlanticus* (holotype). Habit.
Photo by Jaime B. Blanco-Dios.

1.2–1.4 mm per pore), pale orange to yellow ochre when young, becoming orange to rust at maturity, staining intense greenish gray when handled. Stipe 60–130 × 15–55 mm, usually shorter than the diameter of the pileus, attenuate, napiform or fusiform, bright yellow except in the basal third that is reddish to purple, with a long and irregular orange reticulum, except in the upper portion of the stipe (1–2 cm long) where the reticulum is yellow and very fine. Stipe surface changes to blue or grayish blue when bruised. Context firm, soft at maturity, yellow, changing to blue, grayish blue or greenish blue when exposed, except in the lower part where garnet and purple colours dominate. Smell agreeable, more intense in the pileus, generally not distinctive or, sometimes, with garlic smell. Taste agreeable with unctuous texture. Edibility unknown. Chemical reactions: Melzer's reagent: positive in the flesh (deep blue); formol (35%): grayish-blue in the pileus, pores and stipe, almost not visible in the flesh; FeSO4 (10%): gray to greenish in the pileus, stipe and flesh, predominantly gray in the pores. Spore print deep olive-brown.

Basidiospores (10.5–)11.5–14(–15.5) × (4.5–)5.2–6.7(–7.3) µm, Xm = 12.7 × 6 µm, Q = 1.6–2.6(–3), Vm = 240 µm^3, (n = 100), ellipsoid to fusoid, smooth, guttulate, thick-walled, ochre gray in 3% KOH, dextrinoid in Melzer's. Basidia 20.5–35 × 5.5–14.5 µm, 4-spored, rarely 2-spored, sterigmata 2.5–3.5

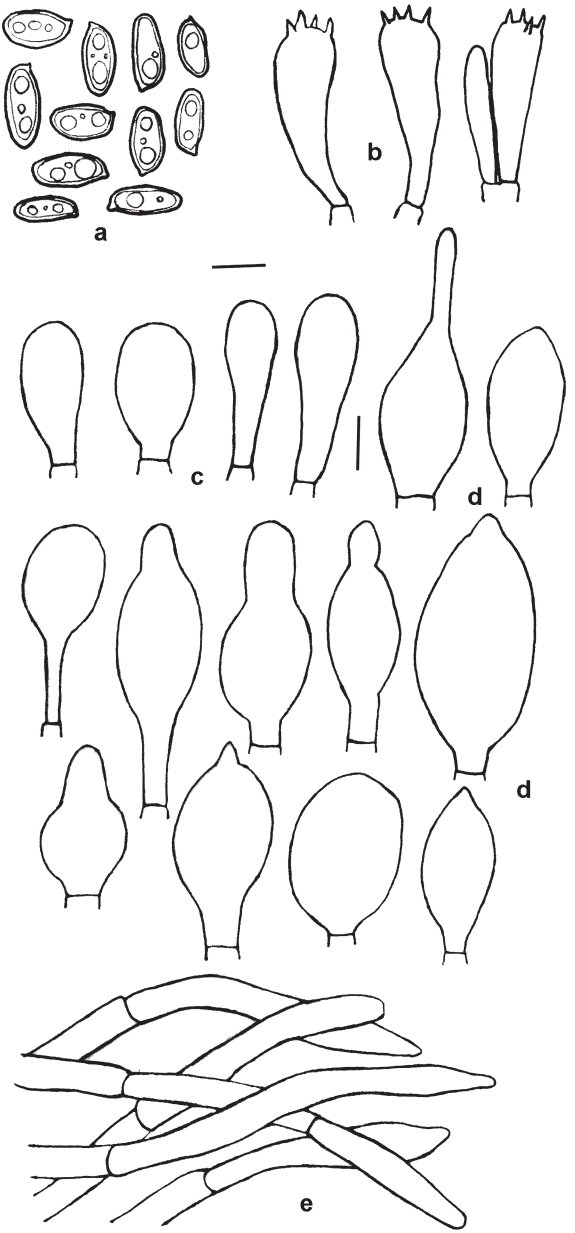

Fig. 1. *Boletus atlanticus* (holotype).
a. basidiospores; b. basidia; c. cheilocystidia; d. caulocystidia; e. pileipellis. Scale bars = 10 µm.

μm long, clavate, numerous basidioles. Cheilocystidia and pleurocystidia 18–37 × 6.5–13 μm, smooth and thin-walled, clavate or sphaeropedunculate, ochre, brown, orange to gray in 3% KOH. Pileipellis a trichoderm consisting of interwoven hyphae 2.5–7 μm broad, long, subcylindric, septate, thin-walled, with brown or gray-brown intracellular pigment in 3% KOH and ochre or ochre-gray in Melzer's; terminal cells 33.5–73 × 4–7.5 μm, Q = 5.3–12.7, long, subcylindric to subfusiform with a rounded or acuminate apex. Stipitipellis consisting of interwoven hyphae 1.5–6.5 μm wide, ochre, brown to gray in 3% KOH and in Melzer's. Caulobasidia 24.5–55.5 × 6.5–17 μm, 4-spored, rarely 2-spored, sterigmata 3–6 μm long, clavate. Caulocystidia 28.5–52.5 × 10–21 μm, smooth and thin-walled, versiform: clavate, fusiform-capitate, lageniform, sphaeropedunculate, pyriform-mucronate or urceolate, ochre, brown, orange to gray in 3% KOH. Basal hyphae of stipe with a strong positive reaction amyloid. No clamp connections observed.

Ecology and distribution- On coastal sand dunes under *Cistus salviifolius* and maritime pines (*Pinus pinaster)*. Known only from a single locality in Spain. October-November.

Additional collections examined: **SPAIN**: **A Coruña**: Santa Uxía de Ribeira, Aguiño, near of Penisqueira beach, 29TMH9708, 10 m, in tertiary or gray dunes, under *Cistus salviifolius* and *Pinus pinaster*, 28.X.2005, leg. F. Romano, J. Sampedro & A. Sampedro (LOU-Fungi 19417); 5.XI.2005, leg. J.B. Blanco-Dios, E.M. Boullosa, I.M. Blanco-Boullosa & M.E Blanco-Boullosa (LOU-Fungi 19419); 11.XI.2008, leg. J.B. Blanco-Dios (LOU-Fungi 19434).

Comments. Possession of orange pores and flesh changing to blue with variable intensity when sectioned places *Boletus atlanticus* in section *Luridi* (Muñoz 2005). This new species is morphologically characterized by a combination of (1) pileus color variably pink, orange, salmon, and yellow with a cream margin, (2) ovoid or triangular pores, (3) bright yellow stipe with the basal third reddish to purple and covered by an orange reticulum from apex to base except at the top of the upper yellow portion, (4) stipe context varying from garnet to purple in the basal third to half or basal third, (5) the pileus, stipe, and flesh staining gray to green (gray in the pores) with $FeSO_4$, (6) habitat in coastal dunes under *Cistus salviifolius* and *Pinus pinaster,* (7) spore Q = 1.6–2.6(–3) and Vm = 240 μm^3, and (8) versiform caulocystidia.

Among the morphologically similar species in sect. *Luridi* with a similarly colored pileus, orange or red pores, stipe with or without reticulum, and context bluing quickly and intensely when bruised or exposed, the closest European taxa are *B. comptus* Simonini, *B. luridus* Schaeff. s.l., *B. luteocupreus* Bertéa & Estadès, and *B. rhodopurpureus* Smotl. f. *rhodopurpureus.*

Boletus comptus differs from *B. atlanticus* in pileus color (variably gray, brown, pink, red, orange, and yellow), reticulum absent or limited to the stipe apex (and then variably yellow, orange, red, and brown), the basal stipe punctate

with reddish brown spots, red mature pores, exposed flesh reddening (and then only on the stipe) or not changing color, and habitat in *Quercus* spp. forests. Microscopically, the basidiospores of *B. comptus* are smaller ((9.5–)10.5–13.1 (–14.8) × (4.3–)4.8–5.9(–6.5) µm) and the caulocystidia are predominantly pyriform or clavate (Simonini 1992, Muñoz 2005, Péric & Péric 2006).

Boletus atlanticus should also be compared with *B. luridus* s.l., widespread in Europe and also reported for Africa, Asia and North America (Smith & Thiers 1971, Thiers 1975, Both 1993, Zang 1999, Bessette et al. 2000, Binder & Hibbett 2004, Muñoz 2005), which differs in pileus color (predominantly ochre and brown in var. *luridus*; red in var. *rubriceps* (Maire) Dermek; and orange or ochre-orange in var. *queletiformis* J. Blum), red pores, a red reticulum restricted to 2/3 of the stipe, and orange-red flesh that is red-purple only at the stipe base and fades to yellow-olive after exposure. *Boletus luridus,* a typical species from broad-leaved forests in calcareous soils, also differs microscopically in its slightly smaller spores [(12–)12.3–13.9(–14.2) × 5–5.9(–6.4) µm], caulocystidia that are fusiform, utriform, or lageniform, and a pileipellis composed of short end cells (Muñoz 2005).

Boletus luteocupreus has a chrome-yellow pileus (sometimes with pinkish tones) becoming ochre-orange with age, a delayed (a few hours) red-coppery or brown-coppery staining reaction, variably reddish pores, a yellow-orange stipe that is red or red-carmine toward the base and almost completely covered with a blood-red reticulum, an association with deciduous forests in acidic soils, smaller spores [(10.4–)10.9–12.3(–12.9) × 4.5–5.3(–5.9) µm], and fusiform or lageniform caulocystidia (Muñoz 2005).

Boletus rhodopurpureus f. *rhodopurpureus*, known also in Asia (Zang 1999; Binder & Hibbett 2004), is distinguished by a pink, purple to red vinaceous pileus, sporocarps with red pores when young and red-orange in age (except at the yellow-orange margin), a yellow or yellow-orange stipe that is red-orange toward the base with garnet or red purple context only at the base and with a red fine reticulum limited to the apex, and a habit in broad-leaved forests (mainly *Quercus* spp.) in acidic soils. It is differentiated microscopically by smaller spores (11.8–13.6(–14.2) × (4.8–)5.1–5.7(–6) µm), and fusiform caulocystidia (Muñoz 2005).

Among extra-European taxa, *B. atlanticus* is morphologically similar to *B. floridanus* (Singer) Murrill and *B. sinicus* W.F. Chiu.

Boletus floridanus, reported from North and Central America (from North Carolina and Tennessee, south to Florida, Texas, Mexico, and Belize), is characterized by a grayish-red, intense red to vinaceous pileus, yellow tubes with red pores, a red markedly reticulated stipe, pale to bright yellow context, a habit in broad-leaved (especially oak) forests, and longer narrower spores (12.8–18 × 4–5.6 µm) (Both 1993; Bessette et al. 2000, 2007; Ortiz et al. 2007).

Boletus sinicus, described from Yunnan (China), has a fibrillose scaly garnet brown pileus, deep red pores, a concolorous (or apically yellow) stipe reticulated with prominent red veins, white or yellowish flesh, and smaller spores (7.5–11 × 4.5–5.5 μm) (Chiu 1948, 1957; Wang et al. 2004).

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